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⑤4繊維状食品の製造法

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⑤7特許請求の範囲

1　水畜産動物肉に食塩を添加、混練して練肉とし、これを細孔を有するノズルを通して蛋白変性剤水溶液中に吐出して繊維強度の調節された繊維状に紡糸成形し、次いで必要に応じて水洗及び加熱を行なうことを特徴とする繊維状食品の製造方法。

2　蛋白変性剤は、みようばんである特許請求の範囲第1項記載の方法。

3　蛋白変性剤はエチルアルコールである特許請求の範囲第1項記載の方法。

4　蛋白変性剤は食塩及び酸であつてかつ食塩濃度が15重量%以上である特許請求の範囲第1項記載の方法。

5　水畜産動物肉に食塩を添加、混練して練肉とし、これを細孔を有するノズルを通して食用油中に吐出して紡糸成型し次いで必要に応じて放置、加温あるいは加熱を行なうことを特徴とする繊維状食品の製造法。

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発明の詳細な説明

本発明は新規な繊維状食品の製造法に関するものである。

近年各種食用蛋白を繊維状に紡糸して繊維性食品をつくる方法が知られ、そのいくつかは実用化されており、得られた繊維状食品はそのまま調理されたり又は、加工食品の素材として利用されたりしている。たとえば大豆蛋白等の植物蛋白を材料とした湿式あるいは乾式の紡糸法がよく知られ、既に実用化されているが、風味や繊維強度やコスト等に問題があつて大量消費段階までには至つていない。

一方魚肉、畜肉等の動物性蛋白を材料とした紡糸法としてはこの動物性蛋白カードをアルカリに溶解して蛋白紡糸液をつくり、それを多孔の小孔から酸、塩凝固浴中に押し出し合成繊維ビスコースと同様な原理で製造するアルカリドープ法がよく知られている。しかしこの方法では得られた製品の食感が固くぼそぼそしたり、あるいは味臭等品質面に難点があり、また原料をアルカリ液に溶解したり、のちに中和したり、あるいははじめアルカリを用いるので各種添加物は、あらかじめ加えることができず、たとえば調味料による調味、色素による着色も紡糸中和後に調味液や色素液に通すなどの手間を要し作業効率にも難点があり実用化されるに至つていない。この他古来からカマボコ原料である魚の練肉をノズルを通して蛋白変性剤等を含んでいない単なる熱湯中へ吐出して、魚そうめんを製造する方法が知られているが、これはカマボコの食感を有する太くて弱いうどん状のものであつて、加工原料素材として他と混合して用いることもなく、筋肉繊維様の繊維状食品とは全く異なるものである。尚最近、魚肉を材料として熱固化した麺線状のものを束ねてなるいわゆるカニ足カマボコが市販されているが、これは平板状カマボコを切断して太い麺線状とするものであつて、紡糸された繊維状食品とは異なるもので

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ある。

かくて本発明は、水畜産動物性蛋白を材料として従来知られている方法とは全く異なる効率的な方法によつて筋繊維様の細さと、しなやかで伸びのある食感を有し、風味良好で品質面においてもすぐれた繊維状食品を製造する方法を提供することを目的とするものであつて本発明者らの実験・研究によれば、かかる目的は、水畜産動物肉に食塩を添加、混練して練肉とし、これを細孔を有するノズルを通して蛋白変性剤水溶液中に吐出して繊維強度の調節された繊維状に紡糸成型し次いで必要に応じて水洗及び加熱を行なうことを特徴とする方法によつて、達成されることが見出されたのである。また、水畜産動物肉に食塩を添加混練して練肉とし、これを細孔を有するノズルを通して食用油中に吐出し、次いで必要に応じて放置、加温あるいは加熱を行なうことによつても上記目的が達成されることを見出された。

本発明方法をさらに詳細に説明すれば、本発明では各種水畜産動物肉を原料として用いることができる。水産動物肉としては、スケソウタラ、カレイ、サバ、イワシ等各種白身、赤身の魚の肉、コエビ、オキアミ等甲殻類の肉、イカ、アサリ等の軟体動物の肉、更に鯨肉等各種の肉を利用することができる。これらは通常新鮮な又は冷凍後解凍されたすり身又はおとし身状の微細肉として用いられる。畜産動物肉としては牛、豚、馬、羊肉や、鶏等各種家禽類の肉を用いることができる。これらは通常ひき肉として用いることができる。

これらの各種水畜産動物肉を適宜1種単独で又は2種以上混合して用いる。その場合水産動物肉のみ1種単独又は2種以上混合でもよく、同様に畜産動物肉のみ1種単独、2種以上混合でもよく、又水産動物肉と畜産動物肉とを混合して用いても良い。目的とする用途、食感等に応じて適宜材料を選択することができる。

このような水畜産動物肉に食塩を添加し、混練して練肉とする。食塩を添加し、混練することにより原料肉中の塩溶性蛋白が溶出して粘稠な肉糊となり糸に引いても切れることなく連続的に紡糸することができる。食塩の添加量は、原料肉の重量に対して1～10%、好ましくは2～4%の範囲である。混練はサイレントカツター、擂潰機等通常の水畜産練製品製造時に用いる装置によつて

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行なうことが出来る。

食塩を添加し混練する際、必要に応じ種々の食品添加物を添加することができる。たとえばコーンスターチ、小麦粉、馬鈴薯澱粉等の澱粉類、グルタミン酸ソーダ等各種化学乃至天然調味料、香辛料、香料、色素あるいは油脂、植物蛋白等であり、目的とする食感、特性等に応じて適宜選択して用いられる。含油量を高めたいときにはサラダ油、白絞油あるいはラード等の植物性又は動物性油脂が用いられる。これら各種食品添加物は原料肉に対して30%程度の量加えても繊維状食品の原料として差支えない。

このように原料の水畜産動物肉に食塩を加え、あるいは必要に応じさらに各種食品添加物を1種又は数種加えて混練して得られた練肉を真空ミキサー等を用いて脱気すれば気泡の混入なく均質となつて好ましい。次にこの練肉を細孔を有するノズルを通して必要に応じて加圧しつつ凝固浴中へ吐出する。このノズルとしては内径1㎜以下好ましくは0.05～0.5㎜の細孔を有する金属製等のノズルが用いられる。

練肉は、このノズルから凝固浴たる蛋白変性剤水溶液中に吐出される。蛋白変性剤水溶液としては、みようばん水溶液、エチルアルコール水溶液、食塩と酸の混合水溶液が好んで用いられる。みようばんとしては通常のカリウムみようばんが用いられるが、このほか食品添加物として用いることのできるアンモニウムみようばんや焼みようばん等も用いることができる。その濃度は0.1～20%、好ましくは0.5～5.0%である。エチルアルコールは、通常脱水や脱脂等に用いられる場合の濃度より比較的薄い水溶液でよく、その濃度は40～80のものが好ましい。

これらの濃度範囲より薄いと蛋白変性効果が得られず適度な物性・食感を有する繊維の紡糸処型が困難となり、一方濃すぎる場合には、繊維の食感が硬すぎて脆くなつたり、味が悪くなつたりして不適当である。

食塩と酸の混合水溶液の場合食塩の濃度は15重量%以上とする。酸としては塩酸、燐酸等の無機酸、酢酸、クエン酸等の有機酸を用いることができる。この場合この水溶液のpHを3.0～5.0の範囲に保つ程度の量の酸が用いられる。この食塩と酸の水溶液には、また酢酸ソーダ、クエン酸

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ソーダ等の緩衝剤としての塩類を加えることもできる。

この蛋白変性剤水溶液は、通常常温で用いられ必要に応じて加温してもよい。ノズルから吐出された練肉はこの水溶液中で通常1秒～3分間で表面の蛋白質がすばやく変性硬化されて、紡糸成型される。かたい繊維状食品を所望の時はこの水溶液中の浸漬時間を長くすることによつてかたくすることもできる。ノズルの太さや吐出圧、蛋白変性剤水溶液の種類、濃度、温度、放置時間等の各種条件を調節することによつて蛋白変性度合あるいは生成繊維の強度を調節することができる。このようにして蛋白変性剤水溶液中に吐出されて紡糸成型されたのちは、必要に応じて水洗し、さらに加熱して蛋白を熱凝固させる。加熱方法としては、通常水中での加熱、加熱水蒸気中での蒸煮、高周波加熱その他任意の加熱方法が用いられる。かくて紡糸成型してあるいは更に水洗、加熱して繊維状食品の製品が得られる。

本発明方法ではまた蛋白変性剤水溶液を用いず代りに食用油を凝固浴として用いても実施することができる。即ち原料水畜産動物肉に食塩あるいは食塩と各種添加物を加え、混練して得られた練肉を1㎜以下好ましくは0.05～0.5㎜の径の細孔を有するノズルから食料油中に吐出することによつても表面蛋白質を変性硬化させ、紡糸成型することができる。この食用油としては通常サラダ油、白絞油等常温で液状の植物性食用油が用いられるがラードその他常温で固状の動物性食用油も加温して液状にして用いることができる。この食用油中での放置時間は通常2秒～2時間、好ましくは1～50分間である。食用油から取出してそのまま製品とすることもできるが必要に応じてそのまま放置したり、加温したり、加熱したりする。

このようにして得られた繊維状食品は、細くてしかも繊維強度が強くしなやかで切れることなく連続的にロールに巻き取ることができる。従つてこの方法はバツチ式でなく連続的に実施することができて有効である。

又本発明の方法によるときは吐出紡糸時の各種条件を調整することにより、蛋白変性度合ひいては繊維強度や伸展性を自由に調節しうる利点がある。このようにして得られた繊維は原料のいかんを問わず植物蛋白原料の繊維やアルカリドープ法の繊維等にくらべて植物蛋白由来の不快な味臭や酸アルカリ味もなく風味良好、色沢優れ、動物筋繊維と同等の形態を有し、特に物性食感面において筋肉繊維と全く同じ強い繊維感と歯応えを有し、しなやかで伸びのある食感は、他に類をみないものである。また調味料や油脂等の添加物をあらかじめ混練時に添加できて有利であり、これが蛋白変性剤水溶液や食用油中で流中してしまうことが少なく、好都合であり、更にアルカリを用いることがないので中和工程等不要で資源やエネルギーの面でも効率的である。

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かくして本発明によるときは動物性蛋白を材料として、細く紡糸成型して品質面において高級ですぐれた繊維状食品を作業効率よく得ることができるものであり、本発明はこの種繊維状食品の製法として誠に有効なものを提供しうるのである。

以下に比較例および本発明の実施例をあげる。

比較例

スケソウすり身に対して、(A,B)食塩2.5％を添加した加塩練肉及び(C)20％水酸化ナトリウム液を1.5％添加してpHを10.5としたアルカリ解膠肉を調製した。なおいずれに対しても化学調味料を2％添加した。

これらを0.5㎜のノズルから押出しそれぞれ第1表のような処理方法で凝固・水洗・加熱を行つて繊維状製品とした。

第　1　表

試　料	処　理　方　法
A　加塩練肉	1％カリみようばん水溶液中で凝固→95℃煮熱→水切り
B　〃	95℃熱水中で凝固→水切り
C　アルカリ解膠肉	1％酢酸、0.3％酢酸ナトリウムならびに食塩5％を含む水溶液(pH 3.9)中で凝固→水洗→95℃煮熱→水切り

各製品の品質は第2表の通りであり、A(本発明方法による調製品)が適度な硬さ、弾力性のある好ましい歯応えと、好ましい風味であるのに比べて、Bは食感が著しく軟くて繊維性が感じられずCはボソボソした劣悪な食感であつて味は無味であつた。

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第 2 表

繊維状食品	食感	風味	引張り強度(g)
A	適度な硬さ、弾力性あり、歯応え良好	良好	23
B	著しく軟く繊維性なし	やや良好	＜1
C	硬くボソボソする	無味	41

なおここで引張り強度の測定はレオメーター（不動工業製）を用いて、繊維状製品8本をまとめて長さ2cmとなるようにアダプターに挟み、試料台移動速度20cm／分にて引張つた時の切断時の応力（1本当りg）を引張り強度とし、この数値と官能判定との相関は第3表のとおりであつた。

第 3 表

引張り強度g	官能判定による食感
＜5	軟く、繊維感乏しい
5～15	やや軟く適度の繊維感あり好ましい
16～35	やや硬く強い繊維感あり好ましい
35＜	硬く繊維強すぎて食感劣る

実施例 1

スケソウタラおとし身100kgに食塩3kgを添加して、真空サイレントカツターにて混練し、得られた練肉を直径0.3mmの吐出口多数を有する砲金製ノズルから、硫酸アルミニウムカリウムみようばん1.5%水溶液中に加圧吐出し、100秒間浸漬後水洗して繊維状食品98.5kgを得た。得られた繊維は美しい白色の細いカニ肉様の繊維で、これをサラダに混じてパネラー22人により官能検査を実施した結果第4表に示すように市販カニサラダと同等の食感があつた。

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第 4 表

	食感を好む人数
市販カニサラダ	12人
本発明繊維状食品入りサラダ	10人

実施例 2

第5表に示す原料配合のものをサイレントカツターで混練し、真空ミキサーで脱気処理を行なつて4種類の加塩練肉を調製した。

第 5 表

原材料名	A	B	C	D
スケソウタラすり身	40	70	—	60
サバおとし身	30	26	—	—
豚ひき肉	—	—	40	—
マトンひき肉	—	—	50	30
分離大豆たん白	10	—	—	3
コーンスターチ	3	—	—	3
大豆油	14	—	6	—
食用色素	0.5	0.7	—	0.5
調味料	0.5	0.5	0.5	0.9
食塩	2.0	2.8	3.5	2.6

これらの練肉を直径0.5mmのノズルから第6表に示すような蛋白変性剤水溶液中に繊維状に押出し、該水溶液中に5分間放置して変性強化させた後水洗して繊維状製品を調製した。また一方該繊維状製品を加熱浴中で5分間加熱後冷水浴中で3分間冷却したものも調製した。また95℃の熱水中に同様に吐出したものを対照とした。各製品の引張り強度をレオメーターにより測定した結果は第6表の通りであつた。

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第 6 表　繊維の引張り強度(g)

蛋白変性剤水溶液		加熱前の製品				加熱後の製品			
溶質	濃度	A	B	C	D	A	B	C	D
カリみょうばん	1%	7	8	5	6	18	21	13	14
エチルアルコール	50	20	21	14	16	18	20	13	14
食塩	20	31	35	22	25	27	33	19	22
酢酸	1								
酢酸ナトリウム	0.3								
食塩	16	30	33	22	24	26	28	18	21
クエン酸	0.3								
対照(95℃熱水)	0	—	—	—	—	1.5	2	1	1

対照品が繊維性を感じない軟弱な食感であるのに対し本発明例の未加熱繊維状製品および加熱処理した繊維状製品の食感はいずれも適宜な歯応えを有する繊維性の好ましい食感であつた。

実施例 3

実施例2の練肉Aを、直径0.3㎜の孔を100個有するプレートから30℃の2%焼みょうばん水溶液中に繊維状に押出し、該水溶液中に30秒間浸漬した後取り出して水洗し、未加熱の繊維状製品を調製した。

また未加熱の繊維状製品を沸騰水中で3分間加熱した製品も調製した。

これらの製品をチョツパーで荒挽きしたものを用いて、第7表の配合にて調製したコンビーフ様缶詰は市販牛肉コンビーフ缶詰とよく似ており、官能検査結果は第8表のとおりであり、食感、風味ともに市販牛肉コンビーフ缶詰とほぼ同等であつた。

第 7 表　コンビーフ缶詰配合%

原材料名	Ⅰ	Ⅱ
未加熱繊維	70	—
加熱後繊維	—	70
精製牛脂	24	24
砂糖	3	3
調味料	2	2
香辛料	0.5	0.5
乳化剤	0.5	0.5

第 8 表　官能検査結果(10点法評点)

試料	外観	食感	風味
本発明例　Ⅰ	7	8	8
本発明例　Ⅱ	8	9	8
市販コンビーフ缶詰	8	8	7

実施例 4

オキアミ生剝き身5kgと、小エビ雑肉1kgとに食塩200g、調味料100g、澱粉150gを添加して擂潰機で混練し練肉となし、これを直径0.5㎜の孔を100個有するプレートから90℃の大豆油中に繊維状に押し出し、3分間該油浴中に放置してゲル化せしめたもの、及び更に130℃の大豆油浴中で2分間加熱したもの各3kgを得た。

これらの繊維状製品は、前者はやや軟く後者はやや硬い食感を有し、いずれも好ましい風味であつた。またレオメーターによる引張り強度測定値は前者9g、後者15gであつた。

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SPECIFICATION

(54) METHOD FOR MANUFACTURING A FIBER-STRUCTURED FOOD PRODUCT

(57) Claims

1. Method for manufacturing a fiber-structured food product comprising adding salt to the meat of a marine animal or of livestock, mixing/kneading the meat into a paste, spin-molding the paste into a fibrous form by discharging it into an aqueous solution of a protein denaturing agent through a nozzle having fine pores so that the fibrous structure having a mechanical strength as desired is formed, washing the fibrous structure as needed, and heating the fibrous structure.

2. The method of Claim 1 wherein the protein denaturing

agent is alum.

3. The method of Claim 1 wherein the protein denaturing agent is ethyl alcohol.

4. The method of Claim 1 wherein the protein denaturing agent comprises salt and acid, and the concentration of salt is 15 wt% or higher.

5. Method for manufacturing a fiber-structured food product comprising adding salt to the meat of a marine animal or of livestock, mixing/kneading the meat into a paste, spin-molding the paste into a fibrous form by discharging it into edible oil through a nozzle having fine pores so that the fibrous structure is formed, and leaving the fibrous structure as it is, or warming or heating the fibrous structure as needed.

Detailed Description of the Invention

The present invention relates to a novel method for manufacturing a fiber-structured food product.

Recently, methods for manufacturing fiber-structured food products have been proposed that comprise spin-molding various kinds of edible proteins into fibers to prepare fiber-structured food products therefrom. Some of those methods have been put into practical use, and fiber-structured food products thus obtained are cooked as they are to be served, or used as a material in the manufacture of other food products. For example, wet or dry spin-

molding method for processing vegetable proteins has been known well, and practiced. However, the products manufactured by the method have not yet been accepted by a large part of consumers because of the problems in association with their flavor, strength of fibers, and cost.

On the other hand, for the method of spin-molding proteins of animal meat such as the meat of fish or livestock, alkali-doping method similar in principle to the method used for manufacturing synthetic fibers such as viscose has been known well. According to alkali doping, curd consisting of animal protein is dissolved in alkali to prepare a protein solution for spin-molding, and the solution is extruded under pressure through a nozzle with multiple tiny orifices to form multiple thin threads of solution flows which are then poured into a bath filled with a protein denaturing solution containing acid and salt. However, the products obtained by this method are problematic in their quality: the product gives a poor eat feel because of its substance being hard and brittle, and its taste and odor are disagreeable. The method has additional problems. According to the method, since the material must be dissolved in advance in alkali solution and then neutralized, additives can not be added to the material before the material is processed and cured into fibers. For example, if it is necessary to add a condiment for seasoning

and a pigment for coloration to the material, the condiment and pigment must be added to the material by immersing, after the material is processed, cured and neutralized into fibers, the fibers in a bath filled with a solution containing the condiment and pigment. This sequence of procedures will take much time and lower work efficiency. Thus, the method is not yet put into practical use. There is also a traditional meat processing method used for obtaining fish meat noodle. This method consists of extruding fish meat paste which has been used primarily for the preparation of boiled fish meat paste (kamaboko), through a nozzle with tiny orifices to produce the threads of fish meat which are then poured into neat hot water which contains no protein denaturing agent, to be hardened. The product consists of threads which, looking like ordinary wheat flour-based noodles, are thicker and more fragile than the ordinary noodles, and give an eat feel like that of kamaboko. The fish meat noodle is eaten as it is, and is not used as a material in combination with other materials to produce food products, and thus it is, in that sense, quite different from the fiber-structured product having a muscle-like texture of this invention. Incidentally, recently so-called crab leg meat consisting of bundles of noodle-like threads of fish meat hardened by heating has been marketed. Preparation of this crab leg meat like

kamaboko consists of cutting a rectangular mass of boiled and hardened fish meat into thick threads to gather them into bundles, which are quite different from the food product obtained by the method of the invention which has a structure consisting of uniformly molded and cured fibers.

The present invention aims to provide a method for manufacturing a fiber-structured food product via a novel and highly efficient process quite different from the conventional processes known heretofore, using, as a material, protein of the meat of a marine animal or of livestock, to produce a fiber-structured food product consisting of long, slender fibers resembling the muscle fibers of an animal which is excellent in its quality: it gives a soft, elastic eat feel, and is flavorful and tasty. As a result of experiments/studies, the inventors found that the above object could be achieved by providing a method comprising adding salt to the meat of a marine animal or of livestock, mixing/kneading the meat into a paste, spin-molding the paste into a fibrous form by discharging it into an aqueous solution of a protein denaturing agent through a nozzle having fine pores so that the fibrous structure having a mechanical strength as desired is formed, washing the fibrous structure as needed, and heating the fibrous structure. They also found that the object could be achieved alternatively by providing a method comprising

adding salt to the meat of a marine animal or of livestock, mixing/kneading the meat into a paste, spin-molding the paste into a fibrous form by discharging it into edible oil through a nozzle having fine pores so that the fibrous structure is formed, and leaving the fibrous structure as it is, or warming or heating the fibrous structure as needed.

The method of the invention will be further described in detail below. According to the invention, it is possible to use the meat of various marine and farm animals as a material. Suitable marine animals whose meat can be used as a material according to the inventive method may include, for white-meat and red-meat fishes combined, Alaska pollack, flatfish, mackerel, sardine, etc.; for crustacea, shrimp, krill, etc.; for mollusks, squid, short-necked clam, etc.; and even marine mammals such as whales. The meat of a marine animal to be used according to the inventive method should be fresh or freshly thawed after being frozen, and chopped or ground to take the form of finely divided pieces. The farm animals whose meat is suitable for the inventive method may include cattle, pigs, horses, sheep, and various poultries such as chicken or the like. The meat of a farm animal is usually used after being ground.

Meat from a single animal species may be used, or meat from two or more animal species may be used in combination as appropriate. When meat from two or more animal species

is used in combination, those animal species may belong together to marine animals or to livestock, or some species belong to marine animals while the other to livestock. The choice of single animal species or two or more animal species in combination may be determined as appropriate according to the given purpose and expected eat feel of the product.

To the meat chosen as above from a marine animal(s) or from livestock, salt is added, and the meat is mixed/kneaded into a paste. While the salted meat is mixed/kneaded, salt-soluble proteins of the meat dissolve in saline to turn the meat into a viscid paste. The paste is so viscid that even when it is stretched by pulling into a thin thread, the thread will not break apart. Thus, it is possible to process the paste into continuously extended fibers. Salt is added at 1 to 10% with respect to the weight of meat serving as a start material, preferably 2 to 4%. Mixing/kneading meat may be achieved by any mixer ordinarily used for mixing/kneading the meat of marine animals or livestock including, for example, a silent cutter or beater.

During the addition of salt or mixing/kneading of the meat, various food additives may be added as needed. For example, additives such as starch including corn starch, wheat flour, potato starch, etc.; synthetic or natural seasoning such as sodium glutamate; spice; aroma; pigment;

and fat and vegetable protein may be added so as to confer a desired eat feel and property to the product. If it is desirable for the product to have an additional content of oil, vegetable oil such as salad oil or purified cooking oil, or animal fat such as lard may be added. Those additives can be added, in total, up to about 30% with respect to the weight of the meat without affecting the quality of the final fiber-structured product.

The meat paste obtained by adding salt to the meat of a marine animal or of livestock and then an additive or several additives in combination as needed thereto and mixing/kneading the salted meat is preferably stirred in a vacuum mixer so that the paste becomes a uniform mass being devoid of air bubbles. Next, the meat paste is extruded under pressure as needed through a nozzle having fine pores in order to spin-mold the paste into a fibrous form by discharging it into an aqueous solution of a protein denaturing agent. Suitable nozzles may include metal nozzles with tiny orifices having an internal diameter of 1 mm or less, preferably 0.05 to 0.5 mm.

The meat paste is extruded through a nozzle into fibers which are then discharged into an aqueous solution of a protein denaturing agent. As preferable aqueous solutions of a protein denaturing agent, may be cited aqueous solutions of alum or ethyl alcohol, or mixed solutions of

salt and acid. Suitable alum may include aluminum potassium sulfate which is commonly used. Besides, aluminum ammonium sulfate or anhydrous aluminum potassium sulfate both of which are officially accepted as food additives may be used. Alum may be added at 0.1 to 20%, preferably at 0.5 to 5.0%. When ethyl alcohol is used, its concentration in water should be lower than the concentration it takes when it is used for dehydration or deprivation of fat. Ethyl alcohol is preferably added at 40 to 80%.

If a protein denaturing agent were added to give a concentration lower than the above range, its protein denaturing effect would be insufficient, and it would be difficult to obtain a fiber-structured product having a satisfactory property and eat feel. On the contrary, if the concentration of a protein denaturing agent were above the above range, the fibrous texture of product would become so hard and brittle as to give a disagreeable eat feel, and its taste would be also impaired.

If a mixed aqueous solution of salt and acid is used as a protein denaturing agent, salt is added at 15 wt% or more. Suitable acids may include inorganic acids such as hydrochloric acid, phosphoric acid, and the like, and organic acids such as acetic acid, citric acid, and the like. Acid should be added to water such that the pH of the resulting solution is in the range of pH3.0 to 5.0. To the

mixed aqueous solution of salt and acid, salts such as sodium acetate, sodium citrate or the like may be further added to serve as a buffering agent.

The aqueous solution of a protein denaturing agent is usually used at normal temperature, but may be heated as needed. Meat paste extruded in the form of fibers from a nozzle is poured in the protein denaturing solution where the fibers are rapidly coagulated to form a uniform fibrous structure. If it is desired to obtain a hard fiber-structured product, this is achieved only by extending the time during which the fibers are immersed in the protein denaturing solution. Adjustment of the coagulation of protein or strength of meat fibers can be achieved by choosing appropriate coagulating conditions according to the meat fibers, that is, by choosing as appropriate the size of orifices of a nozzle, extruding pressure, kinds of protein denaturing agent, and concentration of the protein denaturing solution, its temperature, and duration at which the fibers are immersed in the solution, etc. Being thus spin-molded in the protein denaturing solution, meat fibers turn into a uniform fibrous structure. The structure may be washed with water as needed and further heated so that protein of the structure is coagulated by heating. Heating of the fibrous structure may be achieved by any heating method including, for example, heating in a water bath,

heating in steam, RF radiation-based heating, and others. Thus, the uniform fibrous structure is washed with water, and heated to be hardened into a fiber-structured food product.

According to the inventive method, it is also possible to use edible oil for coagulating meat fibers instead of an aqueous solution of a protein denaturing agent. According to this method, salt, or salt and various additives are added to the meat of a marine animal or of livestock serving as a material, the salted and/or seasoned meat is mixed/kneaded into a paste, and the paste is extruded through a nozzle with tiny orifices having a diameter of 1 mm or less, preferably 0.05 to 0.5 mm, into fibers which are then poured into edible oil so that surface protein of the fiber is altered so much as to be hardened which results in the formation of a uniform fibrous structure. Suitable edible oil may usually include, for example, vegetable oil such as salad oil or purified cooking oil which is liquid at normal temperature, or animal fat such as lard which is solid at normal temperature. The animal fat may be used after it is made liquid by warming. Meat fibers are immersed in edible oil usually for 2 sec to 2 hours, preferably 1 to 50 minutes. Meat fibers may be immediately used as a food product after being immersed in edible oil, or may be left for a certain period before they are used as

a food product, or they may be warmed or heated before they are used as a food product, as needed.

The meat fibers prepared as above to serve as a food product are thin elastic fibers whose mechanical strength is so high that continuous collection of the fibers can be achieved by winding them around a roll without breaking them during operation. Thus, those meat fibers can be effectively produced continuously by a roll-up method instead of discontinuously by a batch method.

Moreover, according to the inventive method, it is also possible to freely control the degree of the protein denaturaion of meat, which means to control the strength and elasticity of meat fibers, etc., by varying necessary parameters involved in the procedures for spin-molding of fibers. Meat fibers obtained as above, in contrast with fibers prepared from vegetable protein, is free from disagreeable taste and odor characteristic with vegetable protein. Furthermore, in contrast with meat fibers prepared by alkali doping, the meat fibers obtained by the inventive method are free from any acid and alkali taste, and provide excellent food products that far exceed in quality corresponding conventional food products: they have a good flavor and attractive luster, are similar in morphology to the muscle fibers of a game animal, and give the same eat feel that will be experienced when the meat of a game animal

is bitten, an eat feel reminiscent of the muscle of animal which is soft, elastic, flexible, and exhibits a springy resistance to bite. The inventive method is also advantageous in that it allows the addition of additives during the time at which meat material is mixed/kneaded, because then the loss of additives as a result of meat fibers being immersed in protein denaturing solution or in edible oil can be minimized. Furthermore, since the inventive method does not involve the use of alkali, it does not require a neutralization step which will lead to the efficient use of natural resources and energy.

Thus, it is possible by taking animal protein and spin-molding it into a fibrous structure comprising thin fibers according to the inventive method, to efficiently provide a fiber-structured food product high in quality. The present invention, therefore, can provide a truly effective method for manufacturing a fiber-structured food product.

The present invention will be further detailed below by means of Comparative Example and Examples.

Comparative Example.

Ground meat of Alaska pollack was treated in three different manners: salt was added to the ground meat at 2.5% (salted ground meat samples A and B), and 20% aqueous solution of sodium hydroxide was added to the ground meat at 1.5% so that the pH of the meat became pH10.5 (alkali-

gelatinized meat sample C). To all the samples, a chemical seasoning was added at 2%.

The samples were extruded through a nozzle with orifices having a diameter of 0.5 mm, and the resulting fibers were coagulated, washed and heated as shown in Table 1 below.

Table 1

Sample	Treatment
A. salted paste	Coagulated in 1% potassium alum sol.-> boiled in 95°C water -> dewatered
B. salted paste	Hardened in 95°C water -> dewatered
C. alkali-gelatinized paste	Coagulated in acid sol. (pH 3.9) containing 1% acetic acid, 0.3% sodium acetate and 5% salt -> water wash -> boiled in 95°C water -> dehydration

The evaluation results of the quality of three samples are as shown in Table 2 below. Sample A (prepared according to the inventive method) had an adequate hardness, exhibits an elastic resistance to bite, and gives an agreeable flavor. Sample B was very soft in texture, and had no fibrous touch, giving only a poor eat feel. Sample C was brittle, gave a very poor eat feel, and was tasteless.

Table 2

Food sample	Eat feel	Flavor	Tensile strength (g)
A	Adequate hardness, elastic, & good resistance to bite	Good	23
B	Very soft, & no fibrous touch	Fair	<1
C	Hard & brittle	Tasteless	41

The tensile strength was determined using a rheometer (Fudo Industrial Co.) as follows: for each sample, a bundle of eight fibers were fixed to an adapter such that a 2 cm long stretch of the bundle was subjected to pulling, and a sample platform was moved at a rate of 20 cm/min until the bundle was broken apart, and the stress (g per one fiber) was taken as representative of the tensile strength of the fiber sample. The tensile strength values of the fiber samples correlated with their evaluation results given by human testers with regard to their eat feel as shown in Table 3 below.

Table 3

Tensile strength	Eat feel based on tester's sensation

(g)	
<5	Soft, poor fibrous touch
5 ~ 15	Slightly soft, adequate fibrous touch, agreeable
16 ~ 35	Slightly hard, strong fibrous touch, agreeable
35<	Hard, strong fibrous touch, poor eat feel

Example 1

To 100 kg of chopped meat of Alaska pollack, 3 kg of salt was added, and the resulting mass was mixed/kneaded with a vacuum silent cutter to form a paste. The paste was extruded under pressure through a gunmetal nozzle with multiple orifices having a diameter of 0.3 mm to form fibers which were then poured into a 1.5% aqueous solution of alum (aluminum potassium sulfate) and allowed to stay there for 100 sec to be coagulated. The coagulated fibers were rinsed with water to give 98.5 kg of a fiber-structured food product. The fiber-structured product consisted of beautiful, white, slender fibers looking like the fibers of crab's leg muscles. The product was mixed with salad. The salad was eaten by a panel of 22 testers who evaluated the taste of salad, particularly the eat feel of the fiber-structured product therein based on their sensation. A

comparative salad was similarly prepared using real crab meat commercially available. The two evaluation results were compared as shown in Table 4 below. As seen from the results, the salad based on the fibrous meat of the invention was evaluated by the testers as good as the comparative salad based on real crab meat.

Table 4

	Number of testers in favor of salad in the left column
Salad based on real crab meat	12
Salad based on fibrous meat of the invention	10

Example 2

Four different combinations of materials as shown in Table 5 were mixed/kneaded with a silent cutter, and deaerated with a vacuum cutter. Thus, four kinds of salted pastes were obtained.

Table 5

Material	A	B	C	D
Ground meat of Alaska pollack	40	70	--	60
Chopped meat of	30	26	--	--

mackerel				
Minced pork	--	--	40	--
Minced mutton	--	--	50	30
Separated Soybean protein	10	--	--	3
Corn starch	3	--	--	3
Soybean oil	14	--	6	--
Pigment	0.5	0.7	--	0.5
Seasoning	0.5	0.5	0.5	0.9
Salt	2.0	2.8	3.5	2.6

Each meat paste having a composition as described above was extruded through a nozzle with orifices having a diameter of 0.5 mm to form fibers which were then poured into an aqueous solution of a protein denaturing agent as described in Table 6 below, and was allowed to stay there for 5 minutes to be coagulated. The coagulated fibers were rinsed with water to give a fiber-structured food product. Some of the fiber-structured food products were further heated by being immersed for 5 minutes in a water bath filled with hot water and then cooled by being immersed for 3 minutes in a water bath filled with cold water. In a separate run, meat pastes having a composition as described above were similarly extruded to form fibers which were then poured into hot water kept at 95°C to produce fiber-

structured products which served as control. The tensile strength of each product was determined with a rheometer, and the measurement results are listed in Table 6 below.

Table 6. Tensile strength (g) of fibers

Protein modifier sol.		Before heating				After heating			
Modifier	%	A	B	C	D	A	B	C	D
K alum	1	7	8	5	6	18	21	13	14
Ethyl alcohol	50	20	21	14	16	18	20	13	14
Salt	20	31	35	22	25	27	33	19	22
Acetic acid	1								
Sodium acetate	0.3								
Salt	16	30	33	22	24	26	28	18	21
Citric acid	0.3								
Control (95°C water)	0	--	--	--	--	1.5	2	1	1

In contrast with the control product which did not exhibit any fibrous touch and gave only a very frail eat

feel, both unheated and heated fiber-structured products prepared according to the inventive method exhibited an adequate resistance to bite and distinct fibrous touch, and gave an agreeable eat feel.

Example 3

Meat paste having a composition similar to paste A of Example 2 was extruded through a plate with 100 orifices having a diameter of 0.3 mm to form fibers which were then poured into a 2% aqueous solution of burnt alum kept at 30°C and allowed to stay there for 30 sec to be coagulated. The coagulated fibers were then rinsed with water to give an unheated fiber-structured food product.

Some of the unheated fiber-structured food products were heated by being immersed in boiling water for 3 minutes.

The unheated or heated product was chopped with a chopper to produce coarsely minced meat. The minced meat was combined with other ingredients as shown in Table 7 to produce a meat-based food product resembling canned corn beef commercially available. The meat-based food product of the invention was compared with canned corn beef commercially available based on the sensation-dependent evaluation given by human testers. The results are as shown in Table 8.

Table 7. Composition (%) of canned corned beef-like products

Ingredients	I	II
Unheated fiber product	70	--
Heated fiber product	--	70
Purified beef suet	24	24
Sugar	3	3
Seasoning	2	2
Spice	0.5	0.5
Emulsifier	0.5	0.5

Table 8. Evaluation results based on human sensation

(Averaged scores given based on a 10 point scale)

Test sample	Appearance	Eat feel	Flavor
Inventive product I	7	8	8
Inventive product II	8	9	8
Commercially available Canned corned beef	8	8	7

Example 4

To 5 kg of raw stripped meat of krill and 1 kg of mixed meat of shrimp, were added 200 g of salt, 100 g of seasoning, and 150 g of starch powder, and the resulting mass was mixed/kneaded with a beater into a paste. The paste was extruded through a plate with 100 orifices having a diameter of 0.5 mm to form fibers which were then poured into soybean oil kept at 90°C and allowed to stay there for 3 minutes to

be gelatinized. Some of the gelatinized fiber products were further heated by being immersed in soybean oil kept at 130°C for 2 minutes. For each of the gelatinized unheated product and gelatinized heated product, a 3 kg sample was obtained.

The gelatinized unheated fiber product gave a slightly soft eat feel while the gelatinized heated fiber product gave a slightly hard eat feel. Both of them exhibited a good flavor. When measured with a rheometer, the tensile strength of the former was 9 g while the corresponding value of the latter was 15 g.